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ALTERATIONS IN SUBJECTIVE EVALUATIONS DURING ACUTE EXPOSURES TO 5-Hz BUT NOT 9-Hz MAGNETIC FIELD DEVICES

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ABSTRACT

In a double-blind study, a total of 64 male and female university students were asked to evaluate their subjective experiences and to complete anxiety and anagram tests while exposed singly within an acoustic chamber to one of four conditions. Three of the conditions involved wearing a belt that contained a Relaxit device. In two of the conditions, the Relaxits generated either 5- or 9-Hz magnetic fields of less than 1 mT while in the third condition only dummy (no magnetic field generated) Relaxits were used. Subjects in the fourth condition did not wear belts and served as procedural controls. Although there were no statistically significant differences between groups for either the anagram or anxiety measures, the group exposed to the 5 Hz Relaxits reported significant increases in several subjective relaxation measures. The effect accomodated not more than 15% of the variance in those measures.

INTRODUCTION

Within the last few years, dozens of small companies have been constructing devices that generate ELF (extremely low frequency) electromagnetic fields. These devices are often sold as nonchemical treatments of recurrent or chronic ailments such as headache, backache, insomnia, or circadian disruption. Unfortunately, many of these ailments are also significantly influenced by placebo or expectancy factors.

Ehermann, et al. (1) were one of the first group of experimenters to test the efficacy of such a device under controlled conditions. They found that

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the reports of chronic headache, arthritic pain, insomnia, circulations difficulties, and general fatigue were significantly diminished in the ELF-exposed groups compared to placebo treatments. Similar effects were found for devices that generated either 9 Hz or 4-12 Hz (statistical variation) fields.

No doubt a particular effect of ELF devices upon people with specific classes of disorders would be important and the requirement for repeated exposures to these fields would not necessarily eliminate their clinical usefulness. However, from a scientific perspective, a short-latency response to these fields would attenuate many of the design problems encountered with chronic treatment programs. For example, many of these devices induce audible frequency-dependent clicks within telephone receivers. Such artifacts (or their absence) could seriously confound treatment conditions.

Some subjects and manufacturers claim that people can "feel" the presence of ELF fields generated by commercial devices. Such "testimonials" are also confounded by demand characteristics of the situation and the failure to properly control for instructional formats. Considering the observation that about 10% of the population is prone to verbal instructions (suggestibility) that can evoke physiological, subjective and memory changes (2), these precautions are by no means insignificant.

The present experiment was designed to answer three questions. First, can the reports of normal volunteers be modified by exposure to ELF magnetic fields? Second, can these effects be determined within double-blind conditions within a laboratory context? Third, can the effects be elicited during a tractable, experimental exposure duration, such as 30 minutes or less? The experiment was also designed to compare two fixed frequency devices (5-Hz and 9-Hz) relative to placebo (with dummy devices) or control (no device) instructions.

METHOD

Subjects

Thirty-two female and 32 male introductory psychology students, 18 to 25

years of age, were selected as subjects. All students participated on a voluntary basis and were rewarded with 2% added to their final grades.

Procedure

Each subject was brought by the experimenter (EM) into a 5 x 6 x 4 m room that contained an acoustic chamber (3.3 x 3.3 x 2.5 m) and ancillary equipment. The subject was presented with a brief explanation about the claims of the Relaxit device and was given the opportunity to withdraw from the study. All subjects agreed to continue.

Subjects were assigned in a serial order to one of eight groups that included the four basic conditions (two of each): control (c), placebo (P), 5-Hz and 9-Hz treatments. The actual test sequency was 9-Hz, P, 5-Hz, C, 5-Hz, P, 9-Hz, C. Each pair of control, 5-Hz and 9-Hz treatments involved two separate Relaxit devices (Electro Medica Office, Rexdale, Ontario, Canada, M9V 2G2). Except for the control groups (which did not involve a Relaxit), the experimenter did not know the treatments.

All six Relaxits looked exactly alike. They were 10 x 5 x 2.5 cm black, plastic devices that were identified by a number between 1 and 8 (the test sequence number). According to the manufacturer, the 5-Hz and 9-Hz Relaxits generated a waveform with a duration of 500 sec (rise time of 50 sec, a gradual drop from a 3.0 V across the coil to 2.5 V during the next 300 sec and then an exponential drop from 2.5 V to 0 within the last 150 sec). Reported intensities of these Relaxits were 10 gauss, 1 gauss, and 0.1 gauss at distances of 50 mm, 100 mm, and 200 mm, respectively, in all three directions. Like the field-generating Relaxits, the placebo devices displayed the operation light; however, the coil was not connected and no detectable ELF fields were generated.

Each subject in the six Relaxit groups was asked to wear a special belt containing one of the Relaxits that placed it at the level of the solar plexus. (This area was selected on the basis of effects reported by the manufacturer.) The subject was then brought into the acoustic chamber and seated at

a desk. Just before the experimenter left the chamber, the Relaxit was turned on with a simple, inconspicuous motion. The doors of the acoustic chamber were then closed.

The same taped instructions were given to all subjects through an intercom. Each subject was first instructed to open a folder, identified with the letter "A" and to complete the enclosed self-report questionnaire within 2.5 minutes. The first part of the questionnaire requested information on: age, sex, year at university, number of cups of coffee or tea that day, medication, chronic illness and physical exercise schedules.

Following two examples, the subjects were given further textual instructions to complete a Self Report on Body Sensations (SRBS) that contained 10 descriptors and 6 questions. Using a 1 (minimum) to 7 (maximum) scale, the subjects were asked to evaluate if they felt: tired, active, nervous, excited, headache, backache, stomach ache, hot, sweaty, or cold. The six questions, also rated on the 7-point scale, were used to reveal response perseveration and included the questions "Does your mouth feel dry?", "Is your heart beating faster?", "Is your heart beating slowly?", Is your stomach making noises?", "Are you relaxed?", and "Are you feeling cheerful?".

When the time had elapsed, the instructions occurred to stop writing and to open folder "B" which contained the IPAT Anxiety Scale Questionnaire. The subjects were instructed to complete this questionnaire during the next 10 minutes. At the end of this period, the subjects were then instructed to stop writing and to open and complete the information in folder "C" within 2 minutes. It contained the identical list of 10 descriptors and 6 questions from the SRBS that had been presented during the first two minutes of the experiment.

The final instructions referred to folder "D" which contained the anagram test. The instructions described the nature of anagrams as "jumbled words" and that the task of the subject was to solve as many of the 100 presented anagrams as possible during a 5-minute period. Two examples were given ALDME

(MEDAL) and LASLH (HALLS). At the end of this period, the experimenter entered the chamber, collected the four folders, removed the belt for the Relaxit conditions, and escorted the subject from the experimental area. Since the Relaxit treatments were given under double-blind conditions, the subjects were not totally debriefed but were given the option to obtain their conditions and responses at the end of the experiment.

Eight separate runs (containing 8 subjects each) were completed. Each alternative run contained members of the same sex. Two to four subjects were tested daily during the school week, between 1000 and 1500 hrs. In addition, the experiment was completed in two parts. The first four runs (two of each sex) were completed between November and December, 1981, while the second four runs (replication) were completed between March and April, 1982.

Once all the data were in the computer, the identification codes for the Relaxit conditions were disclosed. Three way analyses of variance (ANOVA) (4 treatments, 2 sexes and 2 parts of the experiment) were completed for the net change (second evaluation minus the first evaluation) in SRBS measures, IPAT scores and the numbers of attempted and correct anagrams. As a check for possible selection artifacts, three way ANOVAs were completed on the subject information measures (e.g., cups of tea/coffee on the day of the test, etc.).

In addition, IPAT scores and subject's age were covaried with the SRBS change scores before the ANOVAs were performed. All analyses were completed with SPSS software using a Dec 2020 System computer. Measures of central tendency, dispersion and skewness were completed to determine the presence of any outliers. As an extra precaution, all treatment differences were checked by using non-parametric (Kruskal-Wallis) statistics.

Neither the first nor the second author received any renumeration from the manufacturer of the Relaxit. The devices were lent to the laboratory exclusively for the experimental series. An agreement was made between the manufacturer and the second author (MP) before the experiments were begun that he and his colleagues would have complete control of the design, execution and

analyses of the results and that the results would be published regardless of the commercial implications.

RESULTS

The means and standard deviations for the two statistically significant ($p < 0.05$) changes in SRBS for the control, placebo, 5-Hz and 9-Hz treatments as shown in Table 1. Analysis of variance indicated that statistically significant ($p < 0.05$) differences existed between these groups for the sweaty measure ($F = 2.90$, $df = 3, 48$), and for the relaxed measure ($F = 3.04$, $df = 3, 48$). Post-hoc analyses (Scheffes) indicated that only the 5-Hz group demonstrated significantly greater decreased "sweatiness" and increased "relaxedness" compared to the other groups following the 10-minute exposure to the treatments. The means and standard deviations for the group exposed to the two different 5-Hz Relaxits were -1.4 ± 1.8 and -1.5 ± 2.1 for sweaty measure and 2.0 ± 2.6 and 2.5 ± 2.3 for the relaxed measure.

Two marginally ($p < 0.06$) significant changes in SRBS between treatments were noted for the stomach ache ($F = 2.61$, $df = 3, 48$) and dry-mouth ($F = 2.64$, $df = 3, 48$) reports (Table 1). Only Duncan's (post-hoc) analyses indicated that the major source of the significance was the relative decrease

TABLE 1

Means and Standard Deviations for the Largest Changes in Self Report of Body Sensations (SRBS) for the 5-Hz, 9-Hz, Placebo, and Control Treatments. N = Number of Subjects.

	N	Sweaty	Relaxed	Stomach Ache	Dry Mouth
5-Hz	(16)	-1.4 ± 1.9	2.3 ± 1.3	-0.3 ± 1.0	-1.2 ± 2.3
9-Hz	(16)	-0.1 ± 1.5	1.3 ± 1.7	0.4 ± 1.1	0.3 ± 2.0
Placebo	(16)	-0.1 ± 1.2	0.1 ± 1.6	0.1 ± 1.0	0.6 ± 2.0
Control	(16)	-0.5 ± 0.9	0.3 ± 2.6	0.0 ± 0.0	0.0 ± 2.0

in stomach ache intensity and dry-mouth reports by the 5-Hz group compared to the other groups. Because of the inhomogeneity of variance problems encountered in some of the measures, Kruskal-Wallis (non-parametric) one-way analysis of variance was completed on all SRBS measures; the four measures remained or (in the instance of stomach ache) became more statistically significant.

Statistically significant ($p < 0.05$) sex effects were noted for tiredness and coldness measures. Whereas the males reported increased tiredness (0.5 ± 1.1) compared to female subjects (-0.1 ± 2.1) over the session ($F = 3.96$, $df = 1, 48$), the females (0.3 ± 1.5) reported increased coldness ($F = 6.10$, $df = 1, 48$) relative to males (-0.7 ± 1.6). Three way analyses of variance demonstrated a significant ($p < 0.001$) replication effect for the coldness ($F = 7.74$, $df = 1, 48$) measure only. Subjects in the second half (replication) reported a greater increased coldness (0.3 ± 1.7) than the subjects in the first replication (-0.8 ± 1.4). There were no statistically significant interactions between treatment and either sex or replication or both for the change in SRBS reports.

There were no statistically significant differences between treatments on either the IPAT Anxiety (overt or covert) or anagram (attempts or accuracy) scores. Three-way analyses of variance indicated that the subjects in the second half of the experiment (replication) attempted more anagrams (19.1 ± 3.4) relative to the first group (13.1 ± 4.8); ($F = 3.91$, $df = 1, 48$) and had more correct solutions (17.9 ± 3.5) than the first group (12.0 ± 4.9) ($F = 5.30$, $df = 1, 48$). Only sex effects were statistically significant ($p < 0.01$) for the IPAT scores. Females scored ($F = 9.60$, $df = 1, 48$) higher (19.0 ± 8.0) than the male subjects (13.2 ± 6.0) on the overt scale only. There were no significant covert scale effects. No significant interactions existed between treatment or sex or replication for either the anagram or anxiety measures.

Covariance for anxiety or age before the three-way analyses of variance did not appreciably alter the treatment effects on the significant SRBS.

There were no significant differences between exercise schedules, consumption of tea or coffee, or medication between the subjects who had been allocated to the four treatments. Covariance for the numbers of cups of coffee or tea (0 to 3) on the day of the treatment did not alter the basic results. Multiple classification analyses indicated that the largest treatment effects accounted for no more than 15% of the variance in the most affected measures.

DISCUSSION

Brief exposures to either 9-Hz or 5-Hz, pulse-like electromagnetic fields with intensities less than 1m Tesla do not influence problem solving. The scores of volunteers exposed to these devices did not differ in a statistically significant manner from those of subjects who had been exposed to either the placebo or control conditions. These ELF fields were also not associated with any statistically significant changes in scores on a well-known, standardized anxiety test.

The results of these experiments clearly indicate that statistically significant changes in the reports of subjective experiences can be elicited by ELF magnetic fields. Human volunteers exposed for 15 minutes to the 5-Hz Relaxits reported greater relaxation, less sweatiness, less dry mouth and less stomach ache, than either the 9-Hz, control or placebo conditions.

Several factors in the design suggest the reliable nature of this observation. First, all of the exposures were completed under double-blind conditions. Neither the subjects nor the experimenter were familiar with the condition of the three types of Relaxits (5-Hz, 9-Hz, or dummy). Second, the effect was specific to only one frequency and was not associated with the 9-Hz field exposures. Third, both the magnitude and the direction of the effects were the same for two different groups exposed to two different 5-Hz Relaxits.

In addition to the internal consistency of the group effect, several other patterns indicate the reliability of the results. The four most significant subjective experiences are highly intercorrelated measures of "relaxation". Reports of decreased sweatiness, less of a dry mouth and fewer abdom-

inal sensations, are frequently correlated with the general loading of relaxation. Since there were no statistically significant replication (Part 1 versus Part 2) differences or interactions, the effects were not due to peculiarities in a single test series of subjects.

Despite these promising results, caution should be used in their application. The magnitude of the effect was not very large; in fact, the field conditions accomodated for not more than 15% of the variance in the subjective report measures. There were no direct measures of construct validity. In other words, was there really a decrease in sweatiness as measured in changes in resistivity or alteration in dry mouth as measured by saliva flow? These measures were not taken.

One could argue that sitting within an acoustic chamber may have altered the thresholds for hearing sonic components from the devices. Indeed, sonic components have been contaminants in other ELF detection studies (3). However, if the effect was due totally to some general mechanical artifact, subjects exposed to the 9-Hz devices should have been similarly affected as those exposed to 5-Hz conditions.

Alternatively, the concomitant exposure to the Relaxit devices within an acoustic chamber may have been instrumental in the detection of the effect. If one assumes that ELF effects would be mediated through autonomic input to the brain (4) then a marked attenuation of visual-auditory modalities may increase the likelihood of detecting the weaker visceral signals. Modification of autonomic afferent patterns originating within the abdomen by the applied 5-Hz fields could have induced sensations -- perhaps even inaccurate ones -- about the subjective conditions of the viscera.

There is one final methodological problem that has not been considered by experimenters working with human subjects exposed to ELF electromagnetic fields: the mask effect. When subjects are injected with small amounts of adrenalin, the cognitive aspects (the implicit expectancies) of the situation determine the actual label placed upon the consequences of the physiological arousal (5). Even though subjects are exposed to similar, induced physiolog-

ical changes, the emotional experiences -- euphoria, sadness or anger -- are determined by the social context in which they occur.

Despite double blind procedures, if certain ELF magnetic fields (like the 5-Hz Relaxits) induce changes within the adrenergic or cholinergic systems of the body, then the specific instructions and "cognitive aspects" of the situation could determine the actual experience (e.g., relaxation if the study is about relaxation or tension if the study is concerned with unknowns) reported by the subjects. This effect could account for the apparent robust nature of results within a laboratory but the great variability between experimental settings. The contribution of this effect to even a small component of the variance in human experience during ELF exposures would be a constant source of experiment variability. It may not reflect the experimenters, but instead, the nature of the phenomenon.

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